LESSON 5: DETERMINING DISTANCE

PURPOSE

Navigating from one point to another with the use of a map and compass involves the ability to apply simple map reading skills. In previous lessons, we discussed how to plot locations on a map. In these next lessons, we will show you how to determine distance and direction to those locations, both on the map and on the ground. Then, we will show you how to convert a grid azimuth on a map to a magnetic azimuth on the ground and vice versa. When you have successfully completed the next three lessons, you will know "how to get there."

center of mass
nautical miles
representative fraction
statute miles

INTRODUCTION

In previous lessons, we explained that a map is a scaled graphic drawing of a portion of the earth's surface. The scale of the map allows the user to convert distance on it to distance on the ground or vice versa. The ability to determine distance on a map, as well as on the earth's surface, is an important factor in plotting a distant location and determining how to get there.

There are two methods of determining distance on a map using the scales found in the marginal information.

- Mapmakers express a map scale as a **representative fraction**, which gives the ratio of map distance to ground distance. For example, the scale 1:50,000 indicates that one unit of measure on the map equals 50,000 units of the same measure on the ground. The most common units of measurement are miles, meters, and yards.

- Mapmakers divide the graphic (bar) scale into two parts: an extension scale and a primary scale. Use the primary scale, located to the right of the zero, to measure full units; use the extension scale, located to the left of the zero, to measure tenths of a unit. Read the extension scale right to left from the zero and the primary scale left to right from the zero (see Illustration 2.5.1).

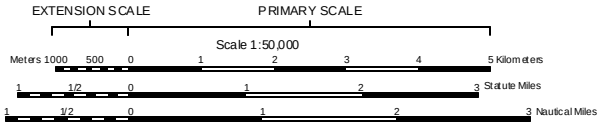


Illustration 2.5.1

Most road maps indicate distance in miles along primary roads between towns, road junctions, or dots. However, this is not the case with topographic maps. When using a topographic map, you must determine the distance between two points because it is not given. To accomplish this, you must first measure the map distance, then convert that measurement to actual ground distance. Using the bar scales is the best way to perform this task.

MEASURING STRAIGHT-LINE DISTANCE

To determine a straight-line distance between two points on a map, lay a straight-edged piece of paper on the map so that the edge of the paper touches both points and extends past them. Make a mark on the edge of the paper at the **center of mass** for each point (see Illustration 2.5.2)

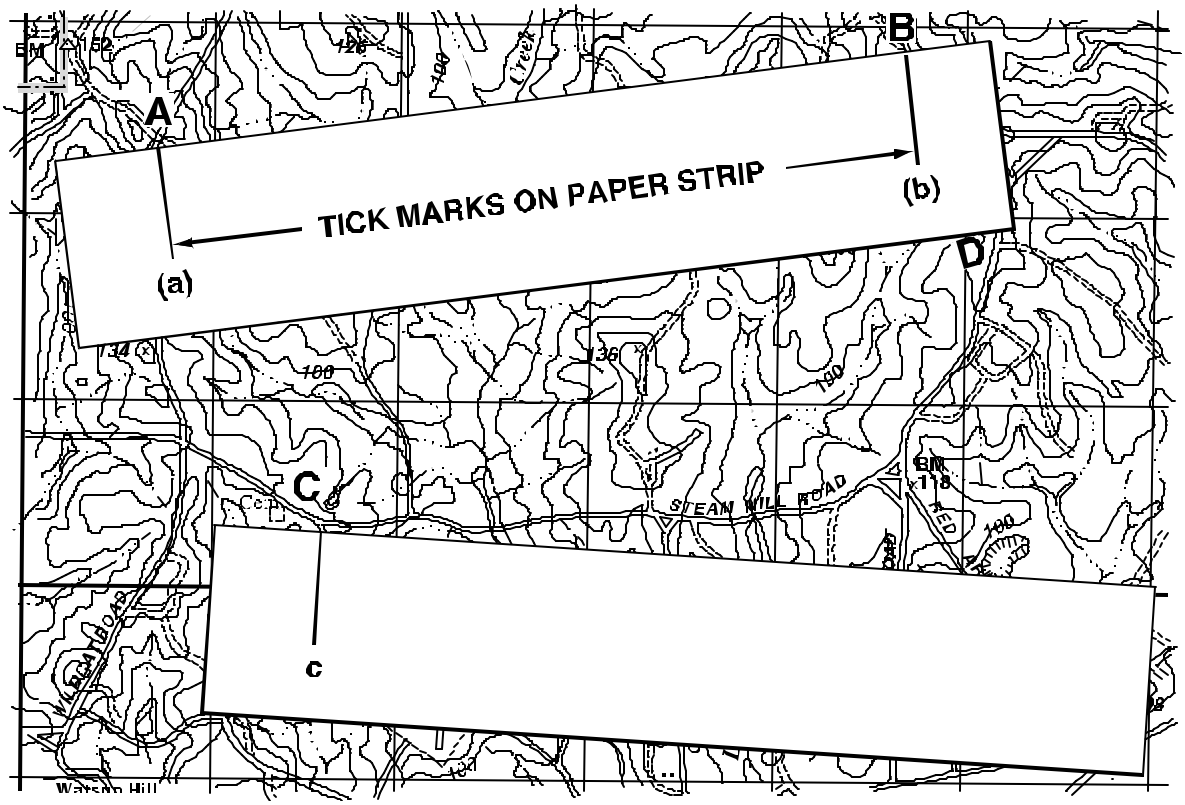


Illustration 2.5.2

To convert the map distance to ground distance, move the paper down to the graphic bar scale, and align the right mark (b) with a printed number on the primary scale so that the left mark (a) is in the extension scale. (See Illustration 2.5.3).

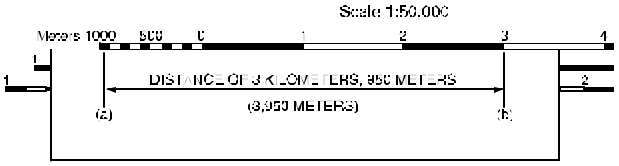


Illustration 2.5.3

In this example, we aligned the right mark (b) with the 3,000-meter mark on the primary scale; thus, the distance is at least 3,000 meters.

Now, to determine the distance between those two points to the nearest 10 meters, look at the extension scale. Since mapmakers number the extension scale with zero at the right and increasing to the left, always read this scale from right to left. Notice that each alternating shaded and clear rectangle is equal to 100 meters. To determine the distance from the zero to mark (a):

⇒ Count the number of whole shaded and clear 100 meter rectangles. In our example, there are nine of them, representing 900 meters.

⇒ Next, mentally divide the distance inside the rectangle containing mark (a) into tenths (or 10-meter intervals) — see Illustration 2.5.4. Since mark (a) is approximately half the distance of that rectangle, or five-tenths, you would add another 50 meters to the total in the first step.

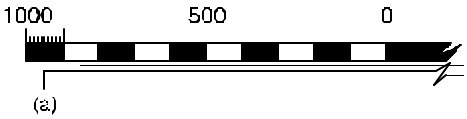


Illustration 2.5.4

Complete your calculations by adding the distance of 3,000 meters (determined using the primary scale) to the 950 meters (determined using the extension scale) the total distance between points (a) and (b) is 3,950 meters.

MEASURING CURVED LINES

To measure a distance along a winding road, stream, or any other curved line, you must first decide on which side of the feature to take your measurement. Never measure from side to side or down the middle. Start by making a mark on the straight-edged paper at the beginning point's center of mass. Move the edge of this paper along the curve, making marks at short straight distances on both the paper and the map as you proceed.

For accurate results, after placing a mark on both the paper and map, proceed to the next straight portion of this distance by pivoting the paper until the edge of the paper and area you are measuring are aligned. Use your pencil to hold the straight-edged paper in place while pivoting. Continue in this manner until you reach the center of mass at the ending point. Then place the paper on the desired bar scale and read the distance between the beginning and ending marks.

In the next example, we will measure the road distance between two points once again, by marking the beginning point (c) on the straight-edged paper (see Illustration 2.5.2). Next, place marks on both the straight edge piece of paper and the map for each straight portion of road between points (c) and (d). Pivot the straight-edged paper as you make the marks on the paper and map until you reach point (d) — see Illustration 2.5.5.

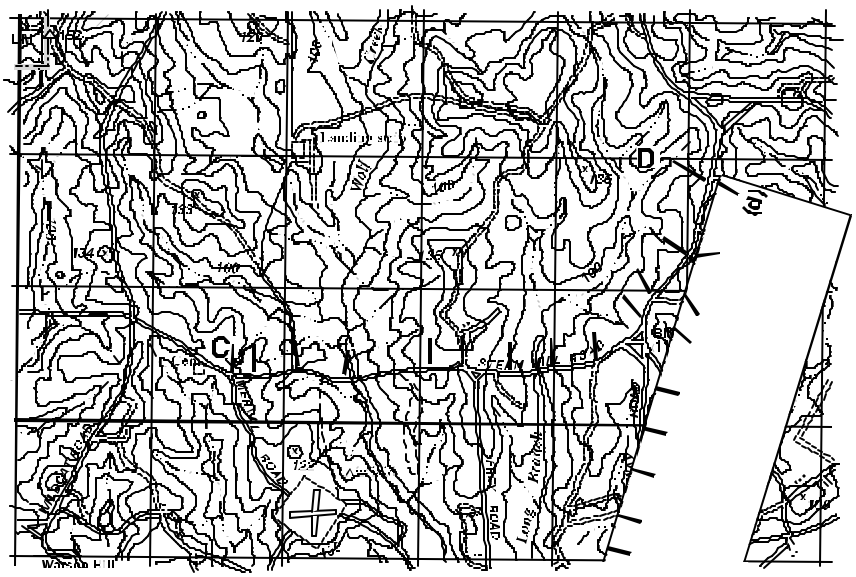


Illustration 2.5.5

Place the straight-edged paper on the correct bar scale. Using only the beginning and ending marks (ignoring the ones in between), calculate the total distance. You can now use the same method as in the previous example. Notice in Illustration 2.5.6 that point (d) falls on the 4,000 meter mark on the primary scale and point (c) is closest to the 550 meter reading on the extension scale. Thus, the road distance between points (c) and (d) is 4,550 meters.

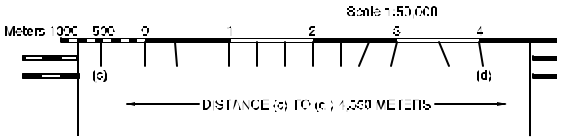


Illustration 2.5.6

CALCULATING DISTANCE THAT EXCEEDS THE SCALE

There may be times when the distance you measure on the edge of the paper exceeds the graphic scale, as in Illustration 2.5.7. When this happens, there is a procedure you can follow to measure this distance. The first step is to align the right mark (b) with the last printed number on the primary scale, in this case — 5 kilometers.

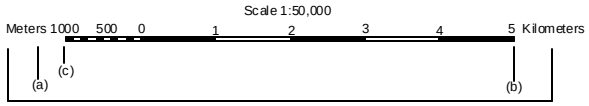


Illustration 2.5.7

When you include the 1000 meters in the extension scale, you can see that the distance from point (a) to (b) is more than 6,000 meters (or 6 kilometers). To determine the exact distance to the nearest 10 meters, place another mark (c) on the edge of the paper at the end of the extension scale. Remember that the distance from point (b) to (c) is 6,000 meters.

Slide the paper to the right to align mark (c) with zero, then measure the distance between marks (a) and (c). Since the distance between marks (a) and (c) is 420 meters, the total ground distance between start and finish points is 6,420 meters (see Illustration 2.5.8).

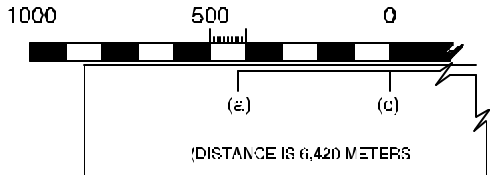


Illustration 2.5.8

CALCULATING DISTANCE TO A POINT OFF THE MAP

To determine distance to a point off the map, measure the distance (straight-line or curved-line) from the start point to the edge of the map. Check to see if the marginal information gives the road distance from the edge of the map to the point you want. Oftentimes, maps will give distances to towns, highways, or junctions off the map. Then, add the distance measured on the map to the distance given in the marginal information. Ensure that the unit of measure is the same. When measuring distance in **statute** or **nautical miles**, round it off to the nearest one-tenth of a mile.

Note: Distance measured on a map does not take into consideration the rise and fall of the land. All distances measured by using the map and graphic scales are flat distances. Therefore, the distance measured on a map will increase when actually measured on the ground. You must take this into consideration when navigating across country.

OTHER METHODS OF DETERMINING DISTANCE

PACE COUNT

One method used to measure ground distance is the pace count. A pace is equal to one natural step, about 30 inches long. In order to accurately use a pace count, you must know how many paces it takes you to walk 100 meters. To determine this, you must walk an accurately measured course and count the number of paces (steps) it takes. The pace course must be on terrain similar to that over which you will be walking. It will not help you very much to walk a course on flat terrain and then try to use that pace count on hilly terrain. Additionally, you may have to adjust your pace count because of the following conditions:

- *Slopes*. Your pace will lengthen on a downslope and shorten on an upgrade.
- *Winds*. A head wind shortens the pace and a tail wind increases it.
- *Surfaces*. Sand, gravel, mud, snow, and similar surfaces tend to shorten your pace.
- *Elements.* Snow, rain, or ice may cause you to reduce the length of your pace.
- *Clothing*. Excess clothing and shoes with poor traction can also affect the pace length.
- *Visibility.* Poor visibility, such as fog, rain, or darkness, can shorten your pace.

There are several methods to keep track of the distance you travel when using a pace count. Some of the most common methods are:

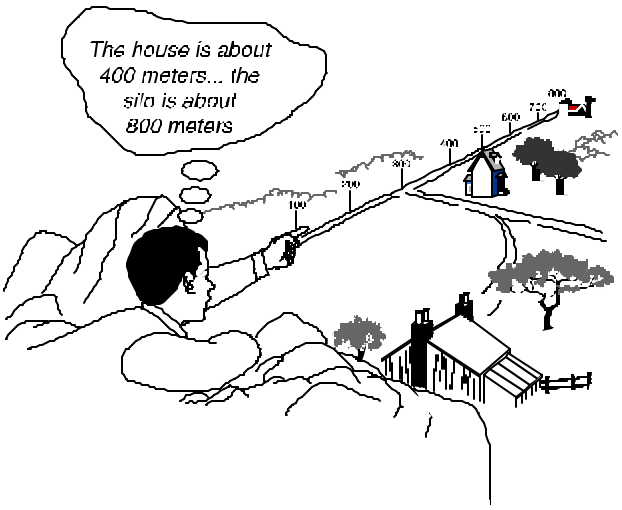
- Put a pebble in your pocket every time you have walked 100 meters according to your pace count.
- Tie knots in a string, (one for every 100 meters)
- Put marks in a notebook, (one for every 100 meters)

Never try to remember the count; always use one of the methods listed above, or design your own method.

ESTIMATION

Another method is to use estimation. To effectively use this method, you must be able to

visualize a distance of 100 meters on the ground. For distances up to 500 meters, determine the number of 100 meter increments between the two objects you wish to measure. Beyond 500 meters, select a point halfway to the objects and determine the number of 100 meter increments to the halfway point, then double it to find the distance to the objects.



CONCLUSION

In this lesson, we described several methods for determining distance and presented them in their order of accuracy. The most accurate method is to use a map scale and to convert the map distance (straight-line or curved-line) to ground distance. However, other ways of determining distance on the ground are by pacing and estimation. Estimation is the least accurate means of determining distance.

* * *